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Understanding daily car use: Driving habits, motives, attitudes, and norms across trip purposes

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ABSTRACT

This paper presents a classification of motives considered as relevant when selecting a mode of transport, and it examines the relative importance of driving habits, car attitudes, descriptive norms and motives for transport mode choices for commuting, shopping, leisure and child-related trips. A survey was sent by post to 3000 Swedish residents in metropolitan, semi-rural and rural areas (with a response rate of 34.6%). Through an ordinal factor analysis, three classes of motives were extracted: Perceived outcomes, Symbolic and Instrumental motives. Hierarchical proportional odds logistic regression and hierarchical linear regression models assess the relative importance of socio-demographic variables, motives, descriptive norms, car attitudes and driving habits for each kind of trip. These models indicate that the impact of socio-demographic and psychological variables varies across trip purposes. Commuting and child- related trips were primarily predicted by socio-demographic variables. Leisure and shopping trips were mostly predicted by driving habit. Driving habit was a common and strong predictor among all trip purposes. These results are evidence of the power of script-based trips to generate habitual travel behaviours across different trip purposes. Conclusions are made in the light of the usefulness of these results to practitioners and researchers who aim to foster sustainable transportation and to reduce private car use.

1. Introduction

This study investigates the relative roles of habits on driving frequency, along with descriptive norms, car attitude and a set of different motives, based on symbolic-affective, instrumental and environmental outcomes. The effects of these variables are investigated for different trip purposes (commuting, shopping, child-related and leisure trips), considering different residential locations (rural, semi-rural and urban areas).

Previous meta-analysis on psychological correlates to car use have classified the decision to use a car as an habitual and cue-based decision, as well as a cognitive deliberated process. Moreover, the trip purposes have been identified as an important moderator on the transport mode choice and therefore it is relevant to be included in this investigation (Gardner & Abraham, 2008; Lanzini & Khan, 2017). The investigation of the relationship of habits with attitudinal, normative and

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motivational aspects is important to help researchers and practitioners to identify in which circumstances transport mode choice is a more deliberate decision and in which they are an habitual and cue-based decision.

The authors of this paper argue that many, but not all, transport mode choices are made under routine events and therefore with low awareness of the outcomes. Even when people plan their activities ahead, they frequently underestimate how much they will use a car (Jakobsson, 2004). Additionally, car drivers tend to negatively evaluate the public transport alternative, biased by misconceptions such as a perceived lack of control over the journey and lower perceptions of safety (Gardner & Abraham, 2007).

Due to such negative outcomes, there is an urgent need to shift transport mode choices from private cars to public transportation as well as active transportation, such as walking and cycling. Furthermore, the role of psychological factors for choosing a private car (motives, attitudes, norms, habits) and the intention of whether to drive or not, is well established in the literature (for an extensive overview see Gardner & Abraham, 2008; Hoffmann, Abraham, White, Ball, & Skippon, 2017).

The transport sector is responsible for 23% of the global greenhouse gas (GHG) emissions and also causes severe local air pollution, including for example particulate matter from physical wear of tires and brakes (World Health Organization, 2018). Adding to the negative effects on the environment, the preference for the private car as the main mode of transportation is also associated with health issues, such as an increase of cardiovascular and respiratory diseases, traffic injuries, and stress due to high levels of noise and traffic congestion within cities (McCarthy, Vaduganathan, & Song, 2018).

Waking up, having breakfast, going to work and taking the kids to school is a simple picture that illustrates the weekly routines of many people. When people wake up and engage in their daily activities, how often have they planned in advance which transport mode that they will use? Daily travel behaviours are often guided by environmental cues and habitual decisions (Aarts & Dijksterhuis, 2000; Fujii & Gärling, 2003; Verplanken, Aarts, & Knippenberg, 1997). Having a car in the garage, or just having a habit of traveling by that transport mode in the past, may be enough for the decision to be made.

1.1. Habits

Repetitive behaviour under similar contexts (e.g. physical, social, spatial or time reference) may be a fruitful condition to develop habitual behaviours. For instance, one may have the habit of actively travelling (by bicycle or walking) on weekends and using a car for commuting. Habitual behaviours emerge as a cognitive facilitator for decision making, leaving more energy for other decisions. In modern societies, deciding which transport mode to use is considered a habitual behaviour unless a change occurs in the context in which the decisions are usually made (Verplanken, Walker, Davis, & Jurasek, 2008).

Habits are correlated with frequency of past behaviour but is not simply reduced to past behaviour (Danner, Aarts, & Vries, 2008). Habits also encompass some degree of conscious cognitive evaluations of people's own behaviour, even in circumstances of high automaticity (Bamberg, Ajzen, & Schmidt, 2003). The main characteristics of habitual behaviour are the lack of conscious intent, a stronger focus on environmental cues to guide the behaviour and 'tunnel vision' (Aarts, Verplanken, & Van Knippenberg, 2010). The term 'tunnel vision' is a description of lack of choice awareness, superficial decision making and little interest in new information (Verplanken & Roy, 2016).

Having the habit to drive when commuting can be generalised across travel purposes (Verplanken, Aarts, & Knippenberg, 1994). Being a frequent driver when commuting can induce the fast decision to also drive in other circumstances, even when there are alternatives available. Research has shown that people with strong car-use habits tend to neglect alternative ways of traveling and to predict a lower satisfaction with a potential use of public transportation (Pedersen, Kristensson, & Friman, 2012).

1.2. Motives for transport mode choice

Transport mode choice can also be influenced by cognitive and deliberate motivational aspects, despite the previously described effects of habitual decision-making (Chng, Abraham, White, Hoffmann, & Skippon, 2018). Steg (2005) classified motives characterised as symbolic-affective, such as displaying social status and a certain prestige through a car as well as positive emotions (enjoying driving), and instrumental motives with practical benefits such as flexibility, time efficiency, and the comfort provided by the vehicle. The expected or perceived outcomes derived from the use of different transport modes may also influence peoples' choices, such as financial costs, health benefits (from choosing active modes rather than riding a bus or driving a car) and the impact on the environment in terms of congestion, pollution and contributing to climate change (Bouscasse, Joly, & Bonnel, 2018). For instance, transport modes perceived as more environmental friendly may be preferred by people with stronger values of environmentalism/universalism (Jaśkiewicz & Besta, 2014).

1.3. Attitudes and descriptive norms

Transport behaviour choices are also influenced by people's attitudes towards different kinds of transport modes and norms. The degree to which people perceive that their peers are using a transport mode influences their intention to use them. These so-called descriptive norms function like a shortcut to decision making and indicates the most likely effective way to behave (Cialdini, 2003; Goldstein, Cialdini, & Griskevicius, 2008; Thøgersen, 2006).

Descriptive norms have shown direct and indirect effects on a diverse set of transport mode choices. Heath and Gifford (2002) found that descriptive norms were direct predictors of public transport use over and above the original factors of the Theory of Planned Behaviour (attitudes, intentions and subjective norms). Passafaro et al. (2014) identified that descriptive norms were one of the direct predictors of emotions towards cycling and had an indirect effect (along with attitudes) on the desire to use a bicycle.

1.4. Changing transport mode choices

A strategy for reducing car use habit and its spillover effects could be adopted under circumstances where people are less habit dependent, such as leisure related trips. Another alternative could be to use circumstantial changes in people's lives (such as changing the home or work place address) in order to implement new transport alternatives. Verplanken and Roy (2016) have shown that moving to another house may create a window of opportunity for people to change their travel habits. The same happens when incentives are inserted into the pool of options, such as reduced fees for public transportation. The mechanism behind such habit discontinuity is that during temporary disturbances people tend to become more sensitive to new information and may adopt different courses of action.

Such kind of interventions would only be effective if we know the extent to which habits influence each kind of trip based on their transport mode, their purpose and the social and demographic areas where people usually travel around. Understanding the mechanisms behind each kind of trip may drive practitioners and researchers to better design interventions.

2. Research questions

The research questions of this study are:

- Which motives do people consider when selecting their transport modes?
- How relevant are those aspects for different trip purposes?
- To what extent do driving habits affect driving frequency for trips with different purposes relative to attitudes, norms and motives?

Habits, attitudes, norms and motive evaluation have different "natures", which means that they are expressed differently through behaviours and are formed by different psychological processes. If the aim is to change people's travel behaviour to a more sustainable way, it would be important to understand the motivational and psychological source of the travel mode choice.

We need to locate the 'hot spot' for behavioural change, thus changing a behaviour that is heavily based on habits would demand social and political strategies which are very different from changing behaviours that are more strongly influenced by attitudes or norms. Identifying the main psychological elements of travel mode choice could provide valuable information to the design of transport systems with features and facilities that match people's demands for different trip purposes. Changing situational aspects of transport systems may be promising, though it is important to remain cognisant that normative, intentional and habitual processes may counteract mechanisms aiming for behavioural change (Klöckner & Blöbaum, 2010).

This study covers urban, semi-urban and rural areas, which is an added relevant aspect for data collection and validity, as it may reduce the sample bias towards dense urban areas or student samples only. Few studies have investigated the effects of psychological variables on transport mode choice in different levels of urbanisation areas. Another important concern for this study is the focus on characterising different trips by their purposes, in order to identify specificities for each kind. To these ends, four categories of trip purposes are investigated: commuting, shopping, child-related activities and leisure trips.

3. Objectives

This study has two main objectives. The first objective identifies classes of motives for choosing a transport mode utilizing an exploratory reasoning. The second objective predicts driving frequency for different trip purposes by the previous classified motives along with driving habits, descriptive norms, attitudes and sociodemographic variables, utilizing a directional test of hypothesis reasoning. The trips were classified as commuting, shopping, child-related activities or leisure, covering trips characterised as routine trips and also as more sporadic trips. Thus, the second objective measures the relative importance of each predictor for driving frequency and tests the hypotheses described next.

4. Hypotheses

H1: Descriptive norms and car attitudes are positively correlated to driving frequency for all trip purposes.
H2: Driving habit is the strongest predictor for trips related to routine activities, such as commuting, shopping and child-related activities, but not to leisure trips.
H3: Psychological variables are stronger predictors of driving frequency than socio-demographic variables.

The next hypothesis was formulated based on the first results of the ordinal factorial analysis, in which three classes representing the motives for selecting a mode of transport were identified.

H4: Perceived outcomes are negatively correlated with driving frequency for all trip purposes; Symbolic and Instrumental motives are positively correlated with driving frequency for all trip purposes.

5. Method

5.1. Sample

The survey was sent by post to 3000 Swedish residents in metropolitan, semi-rural and rural areas (for sample descriptions, see Table 1). The response frequency was 34.6%, with a total sample of 1020 respondents. Since the objectives of this paper are related to driving behaviour, only holders of a driving license were considered. A filter was also applied to control for how typical the respondents perceived their previous week: respondents who reported an atypical week were excluded. The purpose of the filters is to reduce the chances that more drastic confounders could have affected the dependent variables, due to atypical events in people's routines. After applying the filters, the total valid sample size was 885.

5.2. Instruments and procedures

The survey covered a set of items assessing people's evaluation of their daily trips, their attitudes towards modes of transport and self-reported frequencies for trips with different purposes (see Annex). The analyses were performed using the packages MASS version 7.3 (Brian, Venables, Bates, Firth, & Ripley, 2019) and psych version 1.9.7 (Revelle, 2019) from the statistical software R version 3.6.0.

Motives scale (adapted from Steg, 2005)**.** This scale covered aspects related to the environmental impact of transport modes, as well as symbolic and instrumental aspects. The respondents evaluated 13 items with a score range from *Not important at all* (1) to *Very important* (7) based on the following instruction: *"Below, you will find a couple of statements regarding what you view as important when you choose the mode of transport for your daily trips*" (see Table 2).

Driving habit scale (adapted from Şimşekoğlu, Nordfjærn, & Rundmo, 2017; Verplanken & Orbell, 2003)**.** This scale measured how habitual the respondents evaluated their driving behaviour and to what extent cognitive reasoning is demanded to perform this behaviour. The scale is comprised of 6 items (e.g. *"I use my car without thinking about it*") with scores ranging from *Totally disagree* (1) to *Totally agree* (7).

Descriptive norms scale (theoretically based on Thøgersen, 2006)**.** This scale measured participants' perception of private car use by their peers (e.g. *"Most of the people that I know take their car to work*"*)*. The scale was comprised of eight items with scores ranging from *Totally disagree* (1) to *Totally agree* (7).

Attitude scale. The attitude towards cars was assessed by one item: *"In general, what is your attitude to the following transport mode?*". Each of the three transport modes were evaluated based on a scale ranging from *Very negative* (1) to *Very positive* (7).

Travel behaviour scale (Bergstad et al., 2011)**.** The participants answered nine items regarding their trips with different purposes during the previous week (e.g *"How many times have you used different transport modes to get to this activity during the last week?*"). The purposes included trips for commuting (1 question), purchasing goods (2 questions), leisure

Table 1
Sociodemographic variables.

Variable	Mean(SD)/%	N
Car ownership (%)	91	796
Age	50(12.91)	872
Gender (% women)	51.5	456
University education (%)	48.2	419
Single households (%)	14.7	129
Households with children (%)	42.6	377
Type of accommodation (% of detached house)	64.4	570
Household yearly income before taxes (in thousands) (%)		814
<300 SEK	15.1	131
301–500 SEK	25.8	224
501–700 SEK	23.8	207
701–900 SEK	17.2	149
>900 SEK	11.9	103
Municipality population (%)		
<20.000	37.2	329
20.000–50.000	19.3	171
50.000–200.000	20.5	181
>200.000	19.1	169

Note: 1 SEK ≈ 0.095 EURO or 1 SEK ≈ 0.10 USD (Currencies quote date: 30.08.2019.).

Table 2
Statements regarding qualities of transport modes used for importance ratings.

Important motives:	Factor 1 Perceived Outcomes	Factor 2 Symbolic	Factor 3 Instrumental
Low emissions	**0.798**		
Good for my health	**0.749**		
Contributes to sustainable development	**0.736**		
Silent	**0.679**		
Cheap	**0.510**		
Personal Well-being	**0.543**		
It shows who I am		**0.764**	
Social status		**0.961**	
Protection against the weather and wind			**0.687**
To travel fast			**0.687**
Comfort			**0.698**
Cumulative variance	0.256	0.400	0.544

Note: Factor loadings higher than 0.40 are reported. The items *"That I arrive safe"* and *"That it is fun to travel with"* were excluded from the analysis once that this exclusion would increase the variance explained and the factor loadings in the solution.

Table 3
Count of driving frequency by trip purposes.

Driving frequency	Commuting	Shopping (2 items)		Leisure (4 items)			Child-related (2 items)		
		a	b	c	d	e	f	g	h
Never	246	200	429	502	611	375	602	316	328
1 time	55	156	181	86	668	194	89	27	52
2 times	58	175	68	65	39	107	28	22	29
3 times	54	97	36	47	11	41	10	27	21
4 times	46	40	6	10	2	7	3	19	5
5 times	100	22	5	11	1	5	1	32	3
>5 times	177	46	11	15	4	7	3	14	2

Note: Description of components of the classes of trip purpose were (a) shopping for groceries, (b) other purchases (not groceries), (c) sports, exercise or outdoor activities, (d) hobby, courses, associations or religious activities, (e) visiting relatives or friends, (f) going to a restaurant or a café, to entertainment or cultural events, party, concert or cinema, (g) to pick-up or leave children at school or pre-school, (h) to follow or participate in children's leisure activities.

(4 questions) and child-related activities (2 questions). If they had performed the activity, they were asked to indicate how often they have used their car (as drivers and as passengers) on a frequency scale ranging from *Not at all* (0) to *More than* 5 *times* (6) (see Table 3). For each purpose with more than one question, a factor was computed based on ordinal Principal Components Analysis (PCA).

Ordinal factor analysis was also performed to map the characteristics of transport modes regarding instrumental and symbolic characteristics as well as outcomes to the environment and to oneself. The ordinal factor analysis extracts the factors based on the polychoric correlation matrix, instead of the Pearson's correlation usually utilized for metric variables. Extracting factors based on the polychoric correlation matrix is a suitable approach when working with ordinal variables (Gadermann, Guhn, Zumbo, & Columbia, 2012; Holgado-Tello, Chacón-Moscoso, Barbero-García, & Vila-Abad, 2010).

Thereafter, a hierarchical multiple linear regression model utilizing the factor scores was used to identify the relevance of different predictors for shopping, leisure and child-related trips. For the commuting trips, a proportional odds logistic regression was performed with the same predictors that were used on the other models. The reason of this differentiation is that the factors extracted for shopping, leisure and child-related trips are metric, while the commuting trip is an ordinal variable.

For trip purposes, which are the outcomes of the regression models, the method used to compute the factor scores was the Bartlett method. For driving habit and norms, which are the predictors in the regression models, the method to compute the scores was the Regression method. The use of Regression factor scores for the predictors and the Bartlett factor scores for the outcome variables produces consistent estimators for all parameters (Skrondal & Laake, 2001).

6. Results

6.1. Factors extracted from factor analysis for motives

The motives for choosing a specific transport mode were examined by an ordinal factor analysis, with the Varimax rotation method and scores computed by the Regression method. A three-factor solution proved to be the best solution, accounting for 54.4% of the variance based on eigenvalues as well as examining the scree plot visualization (Annex). The Kaiser-Meyer-Olkin's sampling adequacy criteria (KMO) was 0.724, which is an acceptable value according to the recommendations by Kaiser (1974). The Bartlett's test indicated that the null hypothesis that the matrix is an identity matrix was falsified $X^2(55) = 2263.2$, $p < .001$.

The first factor extracted was named Perceived outcomes, with an ordinal reliability coefficient of 0.83 and it accounts for 25.6% of the variance. This factor represents aspects related to the short- and long-term outcomes of transportation. These outcomes cover different levels, such as personal benefits, benefits to society and to the environment. The items aggregated in this factor were related to positive outcomes from the trips: lower carbon emissions, sustainable development, health, silence, general well-being and cheaper prices.

The second factor was named Symbolic, with an ordinal reliability coefficient of 0.84 and it accounts for 14.3% of the variance. This factor represents the intangible aspects related to transport modes. The items covered aspects related to hedonic social status and lifestyles.

The third factor was named Instrumental, with an ordinal reliability coefficient of 0.74 and it accounts for 14.5% of the variance. This factor represents the functional utility of the transport mode, the efficiency and comfort provided by its use. The items covered weather protection, velocity, and comfort. Those are instrumental factors related to basic aspects of transport itself, at the very moment of the trip.

The items had high loadings on the factors, the loadings were well distributed by factors and none of the items loaded over 0.40 in two different factors simultaneously. The internal consistency was satisfactory, with ordinal reliability coefficients of 0.83, 0.84 and 0.74 for the factors Perceived outcomes, Symbolic and Instrumental, respectively. The ordinal reliability coefficients are calculated based on the polychoric correlational matrix (Gadermann et al., 2012; Holgado-Tello et al., 2010).

This result indicates that there are three dimensions of motives which people value as important when deciding about their transport modes. Based on these distinctive factors, matrixes of factor scores were computed and included in the next analysis.

6.2. Factors extracted from factor analysis for driving habits, norms and trip purposes

The items corresponding to the predictive variables driving habit and norms, and the outcome variables trip purposes were also classified in factors by means of ordinal PCA. Differently from the rationale for the factorial analysis for motives, which had an exploratory approach, the analysis for trip purposes, driving habits and descriptive norms had the purpose to form latent variables. In other words, the factorial analysis of motives aimed to identify the underlying latent dimensions of motives, while the analysis for trip purposes, driving habits and descriptive norms aimed to gather their corresponding items in one single factor for each variable.

On the following regression models, the method used to compute the factor scores of the outcome variables was the Bartlett method. For driving habits and norms, which will be subsequently predictors in the regression models, the method to compute the scores was the Regression method (Skrondal & Laake, 2001).

The items were gathered on the following outcome variables: Shopping trips (2 items) with an ordinal reliability coefficient of 0.7; Leisure trips (4 items) with an ordinal reliability coefficient of 0.69; Child-related trips (2 items) with an ordinal reliability coefficient of 0.69.

For the predictive variables, the factors Driving habits (5 items) with an ordinal reliability coefficient of 0.84 and Descriptive norms (8 items) with an ordinal reliability coefficient of 0.70 were computed.

The factors scores extracted from factorial analysis are metric and therefore they were subsequently included in the multiple regression models. However, the outcome variable commuting trips was measured by only one item and therefore no factor analysis was performed for it. Only for commuting that an ordinal logistic regression was performed.

6.3. Regression of frequency of car driving on sociodemographic variables, motives, descriptive norms, attitudes towards the car and driving habits

The factors extracted from the factorial analysis for motives, driving habits and descriptive norms were used as predictors of trips with different purposes (shopping, child-related and leisure trips) on the following analysis of a multiple linear regression model. A proportional odds logistic regression was performed for the commuting trip. The sociodemographic variables of age, gender, city size, income, housing type and presence of children in the household were included in the first step. In the second step, the Factors Perceived outcomes, Symbolic and Instrumental were added along with descriptive norms and car attitudes. The driving habits variable was added in the last step. For the child-related trips, the analysis was restricted to only participants that have kids in the household. In this case, a dummy code based on orthogonal contrast was used for the children variable.

The purpose of the hierarchical regression model is to make salient the added contribution of psychological variables to explain driving frequency (second step of the regression) relatively with sociodemographic predictors. The third step of the regression was important to test the relative importance of habits to improve the model and whether it cause the remaining variables to lose their relations with driving frequency. The literature has identified mixed results regarding the inclusion of habits in steps in the model. While some have identified that habits become the main predictor (Gardner, 2009; Verplanken, Aarts, & Van Knippenberg, 1997), there is also evidence that the predictive value for the other variables (such as attitudes and motives) remain constant even after the inclusion of habits (Şimşekoğlu, Nordfjærn, & Rundmo, 2015).

Table 4
Linear regression models for shopping, child-related and leisure trips (third step).

	Shopping		Child-related		Leisure	
Predictors	β	*p*[CI]	β	*p*[CI]	β	*p*[CI]
Age	0.003	0.488 [−0.005, 0.010]	−0.026	0.009* [−0.045, −0.007]	−0.002	0.306 [−0.007, 0.003]
Gender (female)	−0.245	0.008* [−0.426, −0.063]	0.120	0.507 [−0.236, 0.475]	−0.061	0.263 [−0.179, 0.048]
City size	−0.162	0.158 [−0.388, 0.063]	−0.034	0.880 [−0.472, 0.404]	−0.066	0.325 [−0.194, 0.059]
Income	0.069	0.669 [−0.248, 0.387]	0.476	0.181 [−0.223, 1.176]	0.063	0.511 [−0.149, 0.248]
Housing (house)	0.022	0.854 [−0.209, 0.252]	0.505	0.036* [0.034, 0.976]	0.013	0.855 [−0.016, 0.176]
Children	0.117	0.227 [−0.073, 0.308]	–	–	−0.016	0.784 [−0.144, 0.115]
Perceived outcomes	−0.034	0.499 [−0.131, 0.64]	−0.110	0.270 [−0.306, 0.086]	−0.003	0.907 [−0.070, 0.059]
Symbolic	0.163	0.003* [0.056, 0.270]	−0.009	0.939 [−0.238, 0.220]	0.000	0.992 [−0.066, 0.075]
Instrumental	0.117	0.010* [0.028, 0.205]	−0.015	0.867 [−0.195, 0.164]	0.055	0.050 [−0.014, 0.138]
Descriptive norms	0.007	0.916 [−0.128, 0.143]	−0.125	0.326 [−0.376, 0.126]	0.074	0.070 [−0.009, 0.149]
Car attitude	0.085	0.034* [0.007, 162]	−0.026	0.726 [−0.170, 0.119]	0.038	0.109 [−0.013, 0.087]
Driving habit	0.337	0.000* [0.222, 0.453]	0.315	0.012* [0.069, 0.561]	0.107	0.002* [0.032, 0.182]
Adj. R^2 (AIC)	0.244 (1631.2)		0.189 (561.11)		– (1665.8)	
	$F(21, 537) = 9.57$, $p < .001$		$F(20, 1159) = 3.09$, $p < .001$		–	

Table 5
Proportional odds logistic regression for commuting trips (third step).

Predictors	Coefficient	Standard error	*P* value	Odds ration	CI
Age	−0.026	0.007	0.000*	0.974	0.96–0.98
Gender (female)	−0.503	0.167	0.003*	0.604	0.43–0.83
City size	−0.300	0.021	0.160	0.740	0.48–1.12
Income	1.507	0.316	0.000*	4.517	2.44–8.46
Housing (house)	−0.047	0.215	0.826	0.953	0.62–1.45
Children	0.074	0.178	0.676	1.077	0.75–1.53
Perceived outcomes	−0.193	0.093	0.037*	0.824	0.68–0.98
Symbolic	0.123	0.104	0.236	1.131	0.92–1.38
Instrumental	0.009	0.085	0.912	1.009	0.85–1.19
Descriptive norms	0.251	0.128	0.049*	1.286	1.00–1.65
Attitude	0.039	0.072	0.586	1.040	0.90–1.19
Driving habits	0.795	0.111	0.000*	2.214	1.78–2.76
Intercepts					
1/2	−2.299	0.560	0.000*		
2/3	−1.815	0.556	0.001*		
3/4	−1.412	0.554	0.011*		
4/5	−0.988	0.552	0.073		
5/6	−0.571	0.551	0.299		
6/7	0.329	0.550	0.550		
AIC = 1797.97					

Regarding the assumptions for linear models, there were no evidences for multicollinearity for any of the models and the Variance Inflation Factors (VIFs) were all <5. Moreover, according to the Durbin Watson statistic tests for autocorrelation in the residuals, there were no concerns regarding this criterion for any of the linear models. However, the leisure trips model had small deviation of the normality on the extreme quartiles of the residuals (see Q-Q Plots in the Annex). To account for this deviation, it was used a linear robust regression model based in the M-estimator (weighted least squares) (Wilcox, 2012).

The assumptions for the proportional odds logistic regression was tested using the Brant test. Both the omnibus Brant test and the test for each individual variables had non-significant results, indicating that the parallel assumption for the ordinal logistic regression holds (Brant, 1990). Regarding multicollinearity, only the variable age had VIF > 5, while all the others performed well in this criterion.

For all trip purposes, the model with best fit was the third model, including all psychological variables and driving habits (Table 4, Table 5). The first and second steps of the models are reported in the Annex.

The first hypothesis (H1) of this study predicted that descriptive norms and car attitudes would be positively correlated to driving frequency for all trip purposes. The results give only partial support for H1. Descriptive norms is a statistically significant predictor for commuting ($\beta = 0.441$) and leisure trips ($\beta = 0.091$) in the second step of the model, and only for commuting ($\beta = 0.251$) in the third step. Car attitudes is a statistically significant predictor for commuting ($\beta = 0.162$), shopping ($\beta = 0.128$) and leisure trips ($\beta = 0.058$) in the second step of the model, and only for shopping trips ($\beta = 0.085$) in the third step.

The second hypothesis (H2) predicted that driving habits would be the strongest predictor for trips related to routine activities such as commuting, shopping and child-related activities, but not related to leisure trips. This hypothesis enjoys fairly strong support by the results, driving habit was an important predictor for all trip purposes and the most relevant for leisure and shopping trips (β commuting = 0.795, β shopping = 0.337, β child-related = 0.315, β leisure = 0.107).

The third hypothesis (H3) predicted that psychological variables are stronger predictors of driving frequency than sociodemographic variables. This hypothesis enjoys partial support from the results. Based on the third step of the models, leisure and shopping trips were foremostly predicted by the psychological variable driving habit (β leisure = 0.107, β shopping = 0.337), but commuting and child related trips were foremostly predicted by the socio-demographic variables income and housing, respectively (β commuting = 1.507, β child-related = 0.505).

The last hypothesis (H4) predicted that Perceived Outcomes would be negatively correlated with driving frequency for all trip purposes, and that Symbolic and Instrumental motives would be positively correlated with driving frequency for all trip purposes. This hypothesis enjoys partial support from the results. Perceived Outcomes were negatively associated with driving frequency for commuting trips on both steps (β second step = −0.232, β third step = −0.193). Symbolic motives were positively associated with shopping on both steps (β second step = 0.250, β third step = 0.163,) and commuting trips only on the second step of the model (β commuting = 0.295). Instrumental motives were positively associated with shopping trips on both steps of the model (β second step = 0.185, β third step = 0.117).

7. Discussion

The first objective of the study was to identify classes of motives for choosing a transport mode while the second was to measure the effects of these motives in conjunction with driving habits, descriptive norms and attitudes on the frequency of trips by car. The trips were grouped by four different purposes, based on the PCA: commuting, shopping, child-related activities and leisure purposes.

The first aim was accomplished by means of an ordinal factor analysis, which successfully identified three classes of motives for choosing a transport mode. The classes identified were Perceived outcomes, Symbolic and Instrumental motives.

These three factors had a slightly different grouping compared to other studies on this topic (Anable & Gatersleben, 2005; Bergstad et al., 2011; Steg, 2005), which provides a rich possibility for discussion on the research area of motives for transport mode choice. People recognized Perceived outcomes as one motivational aspect to take in account when selecting a mode of transportation.

Facing acute demands for more sustainable transportation (Banister, 2011), the inclusion of items measuring the Perceived outcomes contributed to go beyond the explanations based only on Symbolic and Instrumental motives. Perceived outcomes also accounted for how much people consider the overall impact of a given mode of transportation such as the cost of maintenance, the level of pollution and the impact on personal well-being.

The second objective was analysed with hierarchical multiple linear regression and proportional odds logistic regression models, which measured the predictive levels of the motives, descriptive norms, car attitudes and driving habits on the frequency of trips by car for the different trip purposes.

The first step of the models covered only sociodemographic variables and it had the lowest variances explained for different trip purposes. This simplest model showed that city size has negative coefficients, indicating a negative correlation to driving frequency. One interpretation is that larger cities may have attractive transport modes other than a private car. This interpretation does not, however, hold for child-related trips. For child-related trips, living in a detached house positively predicts driving frequency and age negatively predicts driving frequency.

The same pattern was found for the variable gender. Gender (being female) had a negative coefficient for all purposes, but it was not significant for child-related trips. This result indicates that women are relatively less frequent drivers for all trips, except for child-related trips. Bergstad et al. (2011) have also found similar results for the effects of city size, households with children and gender on the frequency of private car use.

In the second step, motives, descriptive norms and car attitudes were included in the model. These variables contributed to increase the variance explained for all trip purposes (AIC tests had reduced values). Perceived outcomes motives were relevant for the prediction of commuting trips, Symbolic motives were relevant for shopping and commuting trips and Instrumental motives were relevant for shopping and leisure trips.

Even though people recognize the dimension of the negative consequences to oneself and to the environment due to the use of private car, the results indicate that they are aware of this issue only when it comes to commuting trips. Perceived outcomes was not a predictor for any other trip purposes. This result supports the demand for more communication efforts to increase awareness of the consequences of the use of private car across all trip purposes.

When driving habits was inserted in the model (the third step of the regression), the coefficients of psychological predictors were extremely reduced, while the variance explained by the model increased. Driving habits supressed the relationship of norms and attitudes in leisure trips; it supressed Subjective motives in shopping trips; it supressed Subjective motives and attitudes in commuting trips and it was the only psychological predictor of child-related trips. This result can be understood as evidence of the power of frequent and regular trips to generate strong habitual travel behaviours (Klöckner & Matthies, 2004).

Along with the strong effects of habits, commuting and child-related trips were foremostly predicted by the type of housing and income, respectively. Though, living in a house and having high income is even more strongly associated with driving frequency than driving habits. Moreover, it seems that parents are not influenced by social cues, such as norms and Symbolic motives, neither by cognitive evaluations such Instrumental motives or Perceived outcomes when travelling for child-related activities.

Although the multiple linear models had satisfactory predictive levels and the factor analyses were successful in identifying classes of motives, this study has some limitations. First, the psychological variables have a better explanation for trips that are more regularly based. Other factors should be investigated to better understand transport mode choice for leisure activities and child-related trips. Second, this study is a cross-sectional and correlational study, which does not address causational effects. Therefore, it is not possible to draw causal explanations between the predictors investigated and the frequency of car driving.

This study gives specific information about the key variables predicting driving frequency covering respondents from different levels of urbanisation. This knowledge can be used as supporting material for policy efforts to encourage more sustainable transport systems in cities. Targeting the key contextual and social factors that motivates people to travel more sustainably may be an effective strategy to foster policies encouraging behavioural change (Steg, 2018).

This study has three outcomes that could be relevant for urban planners and other researchers in the area of transportation. First, among the psychological predictors of driving frequency, habits were important across all trip purposes. This means that efforts on communication purposes to change travel behaviour should not focus on motivational or normative aspects, as suggested in previous research (Kormos, Gifford, & Brown, 2015), but rather on alternatives that avoid and or reduces strong habit formation.

Second, it was also identified that the predictive value of psychological variables varies significantly across trip purposes. For instance, if compared to the other trip purposes, leisure trips have a lower relationship with driving habits, which may indicate a window of opportunity to encourage more sustainable alternatives of transport in those contexts. Based on the results of this study, this encouragement could be more efficient if it addresses instrumental aspects of the alternative transport modes that are relevant for the trip.

Third, it was identified that child-related trips are less sensitive to social and situational cues, suggesting that attitudinal and social variables are less likely to change parents' travel behaviour for child-related trips.

Overall, the assessment of sociodemographic variables in relation to psychological variables by trip purposes give to practitioners a good overview of which groups of the population to target for Travel Demand Management (TDM) and in which circumstances it will be less costly to the drivers to change their behaviour (Loukopoulos, Jakobsson, Gärling, Schneider, & Fujii, 2005). Moreover, researchers and practitioners should be aware of which variables were taking in account on the models that they are using to base their decisions and arguments. As this study shows that the inclusion of driving habit in the models, substantially changed the predictive values of the other variables.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trf.2019.11.013.

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